

# THE MARYLAND ENTOMOLOGIST

*Insect and related-arthropod studies in the Mid-Atlantic region*



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The Maryland Entomological Society (MES) was founded in November 1971, to promote the science of entomology in all its sub-disciplines; to provide a common meeting venue for professional and amateur entomologists residing in Maryland, the District of Columbia, and nearby areas; to issue a periodical and other publications dealing with entomology; and to facilitate the exchange of ideas and information through its meetings and publications.

The MES logo features an illustration of *Euphydryas phaeton* (Drury), the Baltimore Checkerspot, with its generic name above and its specific epithet below (both in capital letters), all on a pale green field; all these are within a yellow ring double-bordered by red, bearing the message “\* Maryland Entomological Society \* 1971 \*”. All of this is positioned above the Shield of the State of Maryland. In 1973, the Baltimore Checkerspot was named the official insect of the State of Maryland through the efforts of many MES members.

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## Editor's Note

This issue of *The Maryland Entomologist* contains eight articles and notes submitted by members of the Maryland Entomological Society.

**Joshua P. Basham and Frank G. Guarnieri** provide a key and brief commentary for Maryland's small iridescent jewel beetles in the genus *Chrysobothris* Eschscholtz (Coleoptera: Buprestidae).

**Warren E. Steiner, Jr. and Norman E. Woodley** document the first Maryland records of the deer nasal bot fly, *Cephenemyia phobifer* (Clark) (Diptera: Oestridae).

**Austin P. Platt, Lee D. Miller, and Jacqueline Y. Miller** discuss hybridization in the Viceroy, *Limenitis archippus* (Cramer) (Lepidoptera: Nymphalidae) and report on a possible naturally-backcrossed, male hybrid from Quebec along with supporting laboratory evidence.

**Samuel W. Droege and Leo H. Shapiro** present an addendum to their August survey of wild bees (Hymenoptera: Apoidea) in the northeastern port areas of Baltimore, Maryland.

**Leo H. Shapiro and Samuel W. Droege** offer an addendum to their survey of the bees (Hymenoptera: Apoidea) of the Dominion Cove Point Liquefied Natural Gas Facility and vicinity, Calvert County, Maryland.

**Timothy Foard** documents the first Maryland record for a rare slave-making ant, *Temnothorax duloticus* Wesson (Hymenoptera: Formicidae: Myrmicinae).

**Jennifer A. Frye and Christopher T. Frye** report on their studies of the associations of ants (Hymenoptera: Formicidae) on oaks and pines in inland dune and ridge woodlands in Worcester County, Maryland.

**Eugene J. Scarpulla** summarizes a brief history of the first five volumes of *The Maryland Entomologist* and provides a taxonomic index for all of the articles, notes, etc. that have been published since 1977.

This year's submitted articles and notes again show the excellent studies being conducted, and the notable discoveries being made, by members of the Maryland Entomological Society. I thank the authors for their submittals that further our knowledge of the insects of Maryland. I express my gratitude to the named and anonymous peer reviewers for their insightful comments that enhance each publication. I thank Marcia R. Watson for proofing the final journal copy.

Eugene J. Scarpulla  
Editor

## A Key and Brief Commentary for Small Iridescent Species of *Chrysobothris* Eschscholtz (Coleoptera: Buprestidae) from Maryland

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**Abstract:** Two colorful *Chrysobothris* Eschscholtz species (Coleoptera: Buprestidae) that occur in Maryland are *C. azurea* LeConte and *C. chlorocephala* Gory. The beetles are superficially similar in appearance and this paper is intended to help amateur buprestid enthusiasts distinguish the two species. Furthermore, brief commentaries are provided for three additional *Chrysobothris* species: *C. chrysoela* (Illiger), *C. harrisi* (Hentz), and *C. sexsignata* Say, which could also be confused with *C. azurea* or *C. chlorocephala*.

### INTRODUCTION

The second author collected a small, brilliant purple *Chrysobothris* Eschscholtz beetle (Coleoptera: Buprestidae) while conducting a survey of Coleoptera at Pocomoke River State Park in Worcester County, Maryland (Guarnieri 2010). An image of that beetle, originally identified as *C. chlorocephala* Gory, was posted on the “BugGuide” website, hosted by Iowa State University (Guarnieri 2006). A discussion ensued between the two authors leading to the conclusion that the photograph was mislabeled and was more consistent with *C. azurea* LeConte. To resolve the issue, the physical specimen was sent to Ted C. MacRae (Senior Research Entomologist, Monsanto Company, Chesterfield, Missouri), who confirmed the identification of *C. azurea* based on the presence of fine costae (raised lines) on the elytra (see key below). The beetle was then deposited in the Cornell University Insect Collection in Ithaca, New York.

The genus *Chrysobothris* is an ecologically important group of wood boring beetles that are common in Maryland. The genus is large with approximately 141 species and 3 subspecies in North America (Nelson et al. 2008). No Maryland-specific checklists have been published, but based on Nelson et al. (2008) and the first author’s experience with the genus in Tennessee, the two authors estimate that there could be over 20 species in Maryland.

The genus typically consists of small to medium-sized (5-16 mm [0.20-0.63 in]), grayish beetles with dull copper or bronze reflections. In general, it is difficult for the non-specialist to identify many *Chrysobothris* species, and the situation has been complicated by recent taxonomic revisions. For example, *C. femorata* (Olivier) *sensu lato*, the

omnipresent beetle familiar to most collectors as the Flatheaded Appletree Borer, is now considered a species-group consisting of 12 species (Wellso and Manley 2007).

However, four *Chrysobothris* species that are known to occur in Maryland: *C. azurea*, *C. chlorocephala*, *C. harrisi* (Hentz), and *C. sexsignata* Say, and a fifth species, *C. chrysoela* (Illiger), that may potentially be found in the state, have vivid metallic coloration and/or distinct elytral maculations that should allow for fairly simple and reliable determinations. To facilitate the identification of these beetles, a key with photographic images is provided below.

KEY

Adapted from Fisher (1942) and Downie and Arnett (1996).

1.
- Elytra without spots or irregular designs .....*C. harrisi* (Hentz) (Figure 1)
- Elytra with spots or irregular designs .....2



Figure 1. *Chrysobothris harrisi* (Hentz). 7.5 mm (0.30 in).

- 2(1).
- Elytra with costae (fine raised lines) .....3
- Elytra without costae .....4
- 3(2).
- Body violaceous, cupreous, or bluish. Each elytron with 3 bluish or greenish spots .....*C. azurea* LeConte (Figure 2)
- Body dark bronze-brown, or blackish. Each elytron with 3 reddish, pinkish spots .....*C. sexsignata* Say (Figure 3)



**Figure 2.** *Chrysobothris azurea*  
**LeConte.** 6.9 mm (0.27 in).



**Figure 3.** *Chrysobothris sexsignata*  
**Say.** 10 mm (0.39 in).

- 4(2). Pronotum twice as wide as long. Elytra finely punctate, each with 5 distinct, brilliantly-colored foveae (depressions) .....*C. chrysoela* (**Illiger**) (Figure 4)  
Pronotum not twice as wide as long. Elytra coarsely punctate, each with bluish green foveae, the middle one at most only slightly impressed  
.....*C. chlorocephala* **Gory** (Figure 5)



**Figure 4.** *Chrysobothris chrysoela*  
**(Illiger).** 7.9 mm (0.31 in).



**Figure 5.** *Chrysobothris chlorocephala*  
**Gory.** 7.2 mm (0.28 in).



## BRIEF SPECIES COMMENTARY

*C. azurea*: Typically metallic purple with blue elytral maculations. Length varies from 5.5 to 9 mm (0.22-0.35 in) (Fisher 1942). This is a wide-ranging species found from Florida to Maine and then west to Texas and Idaho (Nelson et al. 2008). Guarnieri (2010) lists the species from Pocomoke River State Park, Worcester County, Maryland. The first author has reared *C. azurea* from maple, *Acer* L. sp. (Aceraceae), in Tennessee.

*C. chlorocephala*: Typically shiny black with blue elytral maculations. Length varies from 5.5 to 7 mm (0.22-0.28 in) (Fisher 1942). Nelson et al. (2008) reports the species from Georgia to New York and west to Michigan and Oklahoma. The first author has collected *C. chlorocephala* from red maple, *Acer rubrum* L., in Tennessee (Hansen et al., forthcoming).

*C. chrysoela*: Typically bronze with bright yellow, green, or orange elytral maculations. Length varies from 7 to 9.5 mm (0.28-0.37 in) (Fisher 1942). This is a southeast coastal species ranging from Texas to Florida to Virginia, possibly extending as far north as Washington, DC (Nelson et al. 2008). However, Norman E. Woodley (Research Entomologist, Systematic Entomology Laboratory, Agricultural Research Service, United States Department of Agriculture[SEL-ARS-USDA], Washington, DC) (in litt.) expressed the concern, after examining the Smithsonian Institution's National Museum of Natural History (USNM) holdings of *C. chrysoela*, that historical references to that beetle in the District of Columbia were likely based on mislabeled specimens in the USNM collection (i.e., two beetles that were labeled "Washington, D.C." but that, in fact, were reared from wood taken at Orlando, Florida) and that tidewater Virginia probably represents the northern boundary of *C. chrysoela*'s range. The two authors have included *C. chrysoela* here based on the possibility that it may eventually be found in extreme southeastern Maryland.

*C. harrisi*: Bright metallic green. Length varies from 5.5 to 9 mm (0.22-0.35 in) (Fisher 1942). Nelson et al. (2008) lists the species from Florida and Alabama north to South Dakota and Maine. The second author has specimens from Allegany County and Anne Arundel County, Maryland and Morgan County, West Virginia. All were collected in June on freshly cut pine, *Pinus* L. sp. (Pinaceae), branches.

*C. sexsignata*: Typically gray with copper or bronze reflections and light pink elytral maculations. Length varies from 6.5 to 12.5 mm (0.26-0.49 in) (Fisher 1942). The range includes the eastern United States, Florida to Maine and west to Texas, Colorado, and Iowa (Nelson et al. 2008). Guarnieri (2010) lists the species from Pocomoke River State Park, Worcester County, Maryland.

## DISCUSSION

Despite their beautiful appearance, the five species described above are not well known by avocational entomologists. In fact, it has been the second author's experience that small iridescent *Chrysobothris* species found by amateur collectors in Maryland are typically referred to as *C. scitula* Gory. According to Fisher (1942), *C. scitula* is very

similar to *C. chlorocephala* with the chief difference being the former having very shallow elytral fovea. However, *C. scitula* is likely confined to the deep south with Nelson et al. (2008) reporting it only from South Carolina, Georgia, Alabama, Mississippi, Louisiana, and Texas. The misidentifications of *C. scitula* in the past may have stemmed from Dillon and Dillon (1961), in which that species is the only small bright metallic *Chrysobothris* mentioned for the eastern United States. This may have given the mistaken impression that a bright blue or green *Chrysobothris* in Maryland would be *C. scitula* by default.

This paper is intended to generate interest in this attractive group of beetles. The key and images presented above should allow the non-specialist to make reasonably certain identifications for these five beetles. Readers would be encouraged to look for them in the field in order to expand our understanding of the role these beetles play in Maryland's forests. Apart from a general understanding of their approximate range in North America (as listed above), any data on county-specific occurrence or even more broad macro-habitat preference (e.g., lowland versus upland distribution) is lacking. Nelson et al. (2008) gives an extensive list of host plant associations that can be summarized as follows: *C. azurea*, *C. chlorocephala*, and *C. chrysoela* feed on multiple deciduous trees and shrubs; *C. harrisi* breeds exclusively in conifers; *C. sexsignata*, on the other hand, is quite unfastidious and has been associated with a broad range of hardwood and softwood species. However, the two authors are unaware of Maryland-specific rearing data for any of the five beetles. Furthermore, there is a lack of understanding of seasonality, relative abundance, and susceptibility to predation or parasitism, and thus the environmental niche filled by these beetles in Maryland remains somewhat cryptic and requires further study.

## ACKNOWLEDGEMENTS

The two authors are greatly indebted to Ted C. MacRae for general advice in preparing the manuscript and for confirming the identification of the *C. azurea* collected from Pocomoke River State Park. Jason B. Oliver (Research Associate Professor, Entomology, Tennessee State University, McMinnville, Tennessee), Stanley G. Wellso (renowned buprestid expert, Bastrop, Texas), Richard L. Westcott (former Taxonomic and Survey Entomologist and former Insect Museum Curator, Oregon Department of Agriculture, Salem, Oregon), and Nadeer N. Youssef (Research Associate, Entomology, Tennessee State University, McMinnville, Tennessee) made numerous helpful suggestions after reviewing early drafts. Norman E. Woodley (SEL-ARS-USDA) was especially helpful in reviewing the final draft, examining the USNM holdings of *C. chrysoela*, and helping define the probable northern limit of that beetle's range in the Mid-Atlantic region.

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## First Records of the Deer Nasal Bot Fly, *Cephenemyia phobifer* (Clark) (Diptera: Oestridae), in Maryland

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Adult bot flies of the genus *Cephenemyia* Latreille are not commonly collected in spite of the abundance of their cervid host. The recent discovery of a live bot puparium (Figure 1) and emergence of the adult fly (Figures 2 and 3), identified as *Cephenemyia phobifer* (Clark) (Diptera: Oestridae) (sometimes incorrectly called *C. phobifera*), inspired this note. Another Maryland specimen was collected as an adult in 2004 (Figures 4 and 5). Of the known Nearctic species of the genus, *C. phobifer* is the only one occurring in the Atlantic states (Bennett and Sabrosky 1962), ranging from North Dakota east to Ontario and Maine, south to Texas, Georgia, and South Carolina. However, no records from Maryland were reported in that study. A check of the Smithsonian Institution's National Museum of Natural History (USNM), Washington, DC, found no Maryland records prior to the two records presented in this article and only one other specimen (non-Maryland) has been added to the USNM collection since the work of Bennett and Sabrosky (1962). Larvae develop in the nasopharyngeal cavities of White-tailed Deer, *Odocoileus virginianus* Zimmermann (Artiodactyla: Cervidae), which are common throughout the state. A survey of deer parasites in the southeastern states did not find *C. phobifer* in Maryland (Kellogg et al. 1971) but infestation rates were often high within the region, with up to 50 larvae recorded from a single animal. The Maryland Department of Natural Resources provides online information on nasal bots in deer (Maryland DNR 2012) but images are from an out-of-state source.

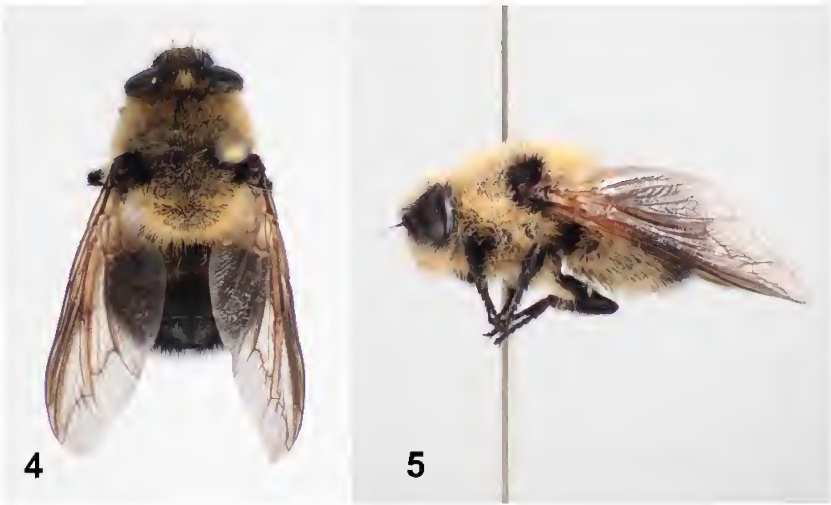
Label data on the two adults specimens are as follows: **1 female**, "MARYLAND: Montgomery Co., McKee-Beshers Wildlife Area, 39°04'30"N, 77°23'00"W, 200 ft., 23 May 2004, N. E. Woodley / *Cephenemyia phobifera* (Clark), det. Woodley 2004" (Figures 4 and 5); and **1 male**, "MARYLAND: Talbot Co., St. Michaels; forest near Perry Cabin, 38°47'40"N, 76°13'40"W, 24 March 2012 (puparium), coll. W. E. Steiner / Found in leaf litter at base of loblolly trunk in mixed open forest; emerged 1 April & preserved 3 April 2012" (Figures 2 and 3). Bearing the same data, the associated empty puparium (Figure 1) is mounted on a card on a separate pin. Specimens are deposited in the USNM.

Bennett (1962) provided a detailed overview of the biology of *C. phobifer*, with most of his work being done in Ontario. He found that 62% of White-tailed Deer were infected with *C. phobifer*, which was considered an underestimate because early instar larvae are

difficult to detect in the host. *Cephenemyia* bots overwinter as larvae in the deer, leave the host when mature, and pupate in the soil (Bennett 1962); adults emerge within 2-3 weeks. Finding the above puparium among surface leaf litter was probably a rare occurrence, but may have been related to the unusually mild winter and high March temperature records with warm-cold fluctuations in 2012. After an earlier than normal emergence, the exposed larva may have been immobilized by cold and so pupated on the forest floor, probably 1-2 weeks prior to its collection. The puparium was kept in a plastic vial with moist leaf litter at about 20°C until the adult fly appeared.



**Figures 1–3. Maryland specimen of *Cephenemyia phobifer* (Clark), Talbot County, puparium collected 24 March 2012: 1) empty puparium from which adult emerged 1 April 2012; 2) adult male that emerged from puparium, dorsal view; 3) same specimen, lateral view.**



**Figures 4–5. Maryland specimen of *Cephenemyia phobifer* (Clark), Montgomery County, 23 May 2004: 4) adult female, dorsal view; 5) same specimen, lateral view.**

### ACKNOWLEDGEMENTS

We thank Gary D. Ouellette (Museum Specialist, Systematic Entomology Laboratory, Agricultural Research Service, United State Department of Agriculture) for photographing the specimens. Wayne N. Mathis (Curator Emeritus of Diptera, USNM Smithsonian Institution), and Alexander S. Konstantinov and Allen L. Norrbom (both Research Entomologists, SEL-ARS-USDA) kindly provided reviews of the manuscript. The USDA is an equal opportunity provider and employer.

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## Possible Natural Backcrossing of a Male Hybrid Admiral, *Limenitis* (Fabricius) (Lepidoptera: Nymphalidae), in Quebec with Supporting Laboratory Evidence

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**ABSTRACT:** The late 19th and early 20th century North American admiral “type” specimens of *Limenitis* (Fabricius) hybrid male interspecific forms of “*arthechippus*” Scudder, “*rubidus*” Strecker (two specimens), and “*weidechippus*” Cross are illustrated together for the first time. This paper reports and describes a female resembling *L. arthechippus*” from southern Quebec. This specimen apparently represents a naturally-occurring backcross, resulting from the presumed mating of an *L. archippus* (Cramer) female with an interspecific male of F<sub>1</sub> hybrid “*arthechippus*.” The results of laboratory backcross matings to female *L. archippus* with F<sub>1</sub> male hybrids of “*arthechippus*” and “*rubidus*” are presented to support the above contention. The evolutionary implications of these studies are considered.

**Key Words:** backcrossing, hybridization, *Limenitis*, speciation, types.

### INTRODUCTION

Interspecific hybridization among the North American admirals, *Limenitis* (Fabricius) (Lepidoptera: Nymphalidae), has continued to be a topic of major evolutionary importance (Porter, 1989, 1990; Boyd et al. 1999; Prudic et al. 2002), especially when the evolution of mimicry and variation in phenotypic wing color patterns are involved. Much of the recent research in this field has involved sophisticated molecular techniques, and in-depth cladistical analyses (Willmott 2003; Mullen 2006; Prudic and Oliver 2008; Oliver et al. 2009; Monteiro and Prudic 2010; Oliver and Prudic 2010). Mullen (2006) investigated evolution and the origins of mimetic wing patterns among all of the important Nearctic *Limenitis* and certain Eurasian outgroups using molecular (mitochondrial and nuclear DNA) techniques and robust phylogenetic analyses. His results generally support the monophyletic origin of the North American admirals.

Nijhout (1991) demonstrated the development and modification of wing patterns in nymphaline butterflies based on pattern formations as described by several early German workers. More recently, the molecular basis of color vision in butterflies (including the

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<sup>†</sup>*Deceased 5 April 2008*

Nearctic *Limenitis*) has been elucidated, and shown to be very similar to the evolution of color vision in certain primates (Frentiu et al. 2007). Predatory insects such as mantids also use prey cuticle luminance and background contrast for unpalatable prey avoidance (Prudic et al. 2007b).

Several species, subspecies, intergrades and hybrid forms of Nearctic *Limenitis* are discussed in this article. These taxa and their affinities are summarized in Table 1.

**Table 1. Taxa (species, subspecies, intergrades, and hybrid forms) discussed in this article.**

<u>Species, Subspecies, and Intergrades</u>		
<i>Limenitis archippus</i> (Cramer)		– Viceroy
<i>L. archippus floridensis</i> Strecker		– “Florida” Viceroy
<i>L. archippus watsoni</i> (dos Passos)		– “Watson’s Gulf Coast” Viceroy
<i>Limenitis arthemis</i> (Drury)		– Red-spotted Admiral
<i>L. arthemis arthemis</i> (Drury)		– White Admiral
<i>L. arthemis arthemis</i> f. <i>proserpina</i> Edwards		– White Admiral/Red-spotted Purple intergrade
<i>L. arthemis astyanax</i> (Fabricius)		– Red-spotted Purple
<i>Limenitis lorquini</i> Boisduval		– Lorquin’s Admiral
<i>Limenitis weidemeyerii</i> W. H. Edwards		– Weidemeyer’s Admiral
<u><i>Limenitis archippus</i> Hybrid Forms</u>		
“arthechippus” Scudder	( <i>L. a. arthemis</i> x <i>L. archippus</i> )	– White Admiral x Viceroy
“rubidus” Strecker	( <i>L. a. astyanax</i> x <i>L. archippus</i> )	– Red-spotted Purple x Viceroy
“weidechippus” Cross	( <i>L. weidemeyerii</i> x <i>L. archippus</i> )	– Weidemeyer’s Admiral x Viceroy

Interspecific hybridization among the Nearctic species of *Limenitis* is a well-known phenomenon with important evolutionary implications. Within this genus several species and forms are involved in two very different mimicry complexes (Platt et al. 1971). Hybrid crosses involving the Viceroy, *L. archippus* (Cramer), and the other eastern admirals, White Admiral, *L. arthemis arthemis* (Drury), and especially Red-spotted Purple, *L. arthemis astyanax* (Fabricius) have been widely reported (Edwards 1884; Scudder 1889; Holdridge 1899; Gunder 1934; Platt 1975, 1983, 1987; Platt et al. 1978; Ritland 1990; Kemp 1991; Platt and Maudsley 1994; Covell 1994, 1999; Schiefer 1999, 2000; Ross and Marks 2002). Likewise, interspecific crossing of montane western butterflies, Lorquin’s Admiral, *L. lorquini* Boisduval, and Weidemeyer’s Admiral, *L. weidemeyerii* W. H. Edwards, with *L. archippus*, has been described often (Cross 1936, 1937; Gage 1970; Perkins and Gage 1970; Simpson and Pettus 1976; Platt et al. 1978; Dornfeld 1980; Platt 1983; Dankert and Nagel 1988; Boyd et al. 1999). Restricted regions of hybridization occur between the various subspecies within both of these western complexes, and between both western species and the eastern *L. arthemis-astyanax* complex (Remington 1958, 1968).

In this paper we shall review the early described “type specimens” of interspecific hybrid forms “arthechippus” Scudder, “rubidus” Strecker (two early specimens), and



“weidechippus” Cross. Such descriptive names, when applied to hybrid forms are not recognized as being valid in the formal sense of the International Code of Zoological Nomenclature (Masters 1972; Miller and Brown 1981; Hodges 1983), but for this genus they are widely known, have been used often, and describe specific genetic entities. Thus, we shall refer to them in quotation marks and in roman type, to stress their informal usage.

In 1996, Platt recognized an unusual phenotype of a much worn female admiral in the collection of the Allyn Museum of Entomology, Sarasota, Florida. This specimen most resembled *L. archippus* with which it had been curated. It was collected at Lanoraie, Quebec, Canada in the late 1930s (AME Accession Number 1980-13). The specimen possessed darkened forewings which closely resembled those of hybrid form “arthechippus,” but its light orange hindwings clearly were those of *L. archippus*.

### MATERIALS AND METHODS

The following abbreviations, representing museums and insect collections, are used in this paper:

AME	Allyn Museum of Entomology, Florida Museum of Natural History, Sarasota, Florida (now housed at the MGCL/FLMNH, University of Florida, Gainesville, Florida)
AMNH	American Museum of Natural History, New York, New York
FMNH	Field Museum of Natural History, Chicago, Illinois
MGCL/ FLMNH	McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, Florida
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
UMBC	University of Maryland Baltimore County, Baltimore, Maryland (“Platt Collection” now housed at the MGCL/FLMNH, University of Florida, Gainesville, Florida)
USNM	National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia

Photographs of the four early wild-collected male “type” specimens of interspecific *Limenitis* hybrids are included for comparative purposes.

The presumed backcross female is very flight-worn. J. Y. Miller dissected this female’s abdomen to check for spermatophores, to determine whether she had bred prior to capture.

The two backcross broods, “arthechippus” and “rubidus,” were bred in the laboratory at UMBC by Platt in 1977 and 1983, respectively. They are reported here to provide evidence that the AME specimen is indeed a naturally occurring backcross. The laboratory strains were established using central Maryland (Anne Arundel, Baltimore, Cecil, and Frederick Counties) *L. archippus*, as well as *L. arthemis arthemis* from Starksboro (Addison County), Vermont. The F<sub>1</sub> hybrid males were obtained by making reciprocal hand-pairings of the various interspecific strains (Platt 1969). F<sub>1</sub> hybrid males stunned in potassium cyanide (KCN) killing jars were hand-paired to freshly eclosed virgin *L. archippus* females. The bred females then were confined singly in nylon organza oviposition bags covering their weeping willow, *Salix ×sepulcralis* Simonkai [*alba* × *pendulina*] (Salicaceae), foodplants on which the F<sub>1</sub> and backcross larvae were reared as separate broods.

## RESULTS

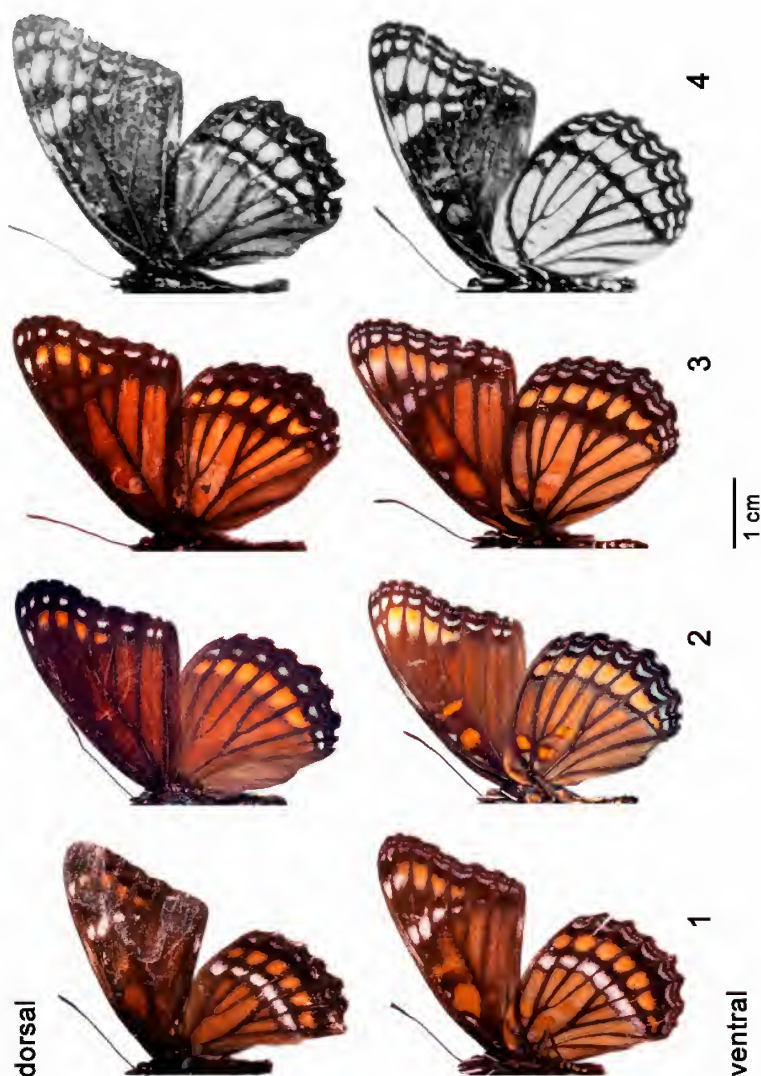
### **The Early Interspecific Hybrid “Types”**

The three previously described field-collected “type” specimens of the early interspecific hybrids involving *L. archippus* and its congeners are illustrated (Figures 1-4). The “type” of the hybrid “arthechippus” (Figure 1) and the “types” of “rubidus” (Figures 2 and 3) possess different phenotypes. The main difference between these two hybrids is either the presence (“arthechippus”) or absence (“rubidus”) of the post-medial white spots on the forewings and the post-medial white bands on the hindwings. Strecker (1872-78) merely named the hybrid form “rubidus” and referred to a brief, vague description by Mead (1872) based on a specimen that Mead had seen offered for sale through the AMNH. The second specimen of “rubidus” (Figure 3) is deposited in the MCZ and bears a red type label with the hand-written inked name “R. M. Grey” and is curated along with Scudder’s “type” of “arthechippus.” The identities, collection information and the whereabouts of these “types” (when known) are presented in the figure captions.

The type specimen of the hybrid “weidechippus” Cross (Figure 4) was originally part of the C. D. Schryver Collection in Colorado. These photographs are copies obtained from the USNM and are illustrated by Cross (1937). Upon his death in 1959, portions of the Schryver Collection purportedly were sold at auction. Attempts were made to locate this original “type” specimen in the collections of the Natural History Museum in Denver, but it could not be found.

### **The Presumed Backcross Specimen**

As stated above, a female *L. archippus*-like admiral (Figure 5) was found in the AME collections. The specimen had been collected at Lanoraie, Quebec, Canada and originally was part of the F. H. Chermock Collection. The butterfly is quite worn, with the entire tornal area of the left forewing abruptly cut away, resembling an avian “beak tear.” The right forewing also is very tattered, and the right hindwing is missing several large marginal chips. However, the left hindwing is nearly intact. All of the wings



**Figures 1-4. “Types” and early specimens of interspecific *Limenitis* male hybrids:** 1) “Type” of hybrid “arthechippus” Scudder, Chateauguay Basin, Quebec, vicinity of Montreal, September 1879, J. G. Jack, MCZ.; 2) “Type” of hybrid “rubidus” Strecker, Berks County, Pennsylvania, prior to 1872, T. L. Mead, Strecker Collection., FMNH, Chicago, Illinois; 3) Hybrid “rubidus”, vicinity of Helderberg Hills, southwest of Albany, New York, prior to 1879, R. M. Grey, Edwards Collection, MCZ; 4) “Type” of hybrid “weidechippus” Cross, along Platte River, near Denver, Colorado, circa 1936, C. D. Schryver Collection; present location of the specimen is unknown to the authors.

**dorsal****ventral****5****1 cm**

**Figure 5. Wild-collected (presumed backcross) specimen most likely representing the pairing of an *L. archippus* female with an F<sub>1</sub> hybrid “*arthechippus*” male.** The specimen’s forewings are dark orange-brown and very “*arthechippus*”-like, whereas, its hindwings are light orange and possess the black central medial line and row of iridescent white submarginal lunules of *L. archippus* itself. AME, Accession Number 1980-13, Lanoraie, Quebec, 28 August 1938, F. H. Chermock Collection. The specimen was not available for color photography of the ventral view; the ventral photograph was taken prior to dissection of the corpus bursa.

appear to have been badly rubbed and are missing scales, showing wear both at their apices and along their lateral margins.

The ground color of both forewings is a dark, dull chestnut, or mahogany brown. Their coloration and patterns closely resemble those of the “type” specimens of hybrids “arthechippus” and “weidechippus” (Figures 1 and 4). However, the hindwing coloration and patterns clearly are those of *L. archippus*, with the forewing ground color nearly as dark as that of *L. archippus floridensis* Strecker. The hindwing iridescent marginal lunules are single and whitish, similar to *L. archippus*. There are faint indications of a small, white postmedial “spot-band” alongside the proximal margin of the medial black hindwing bands. Dissection of the female’s corpus bursa revealed that it contained no spermatophores and, therefore, she likely had not mated, despite her very flight-worn condition.

The locality in which this specimen was collected is in the Canadian Laurentides, beside the St. Lawrence River and just southwest of Lac St. Pierre Park at Lanoraie-d’Autray, Quebec. The habitat is in the middle of sphagnum, *Sphagnum* L. spp. (Sphagnaceae), bogs or “muskegs,” particularly black spruce, *Picea mariana* (Mill.) Britton, Sterns & Poggenb. (Pinaceae), bogs. This represents a classic collecting area for several genera of localized bog butterflies, including *Boloria (Clossiana)* Reuss (fritillaries); *Lycaena (Epidemia)* Scudder (coppers); *Callophrys (Incisalia)* Scudder (elfins); and *Oeneis (Oeneis)* Hübner (arctics). Early collectors usually frequented such bogs between May and early July.

### **The Laboratory Backcrosses**

Two laboratory backcrosses involved breeding freshly emerged female *L. archippus* to laboratory reared F<sub>1</sub> males of hybrid forms “arthechippus” and “rubidus” in 1977 and 1983 respectively (Table 2). Together, the two broods produced a total of 98 backcross progeny, including 68 males and 30 females. The progeny segregated into “hybrid-like” (36%; N=35) versus “parent-like” (64%; N=63) offspring. The overall sex ratio was biased in favor of males, the homogametic (ZZ) sex among butterflies. In each brood separately, and for the combined data, statistical deficiencies of females occur. The  $\Sigma\chi^2_1$  (Yates Correction) values are as follows: Brood 1 = 7.70\*\*, Brood 2 = 9.38\*\*, and combined broods = 14.90\*\*, with  $p < 0.01$  in all three tests. The null hypothesis for each of these tests assumes a 1:1 ratio. The “hybrid-like” progeny of Brood 2 segregated 1:1 between “arthechippus”-like and “rubidus”-like. Both groups of these insects can be further subdivided into groups with “light” (more *L. archippus*-like) and “dark” (more *L. arthemis-astyanax*-like) wing ground coloration.

Figures 6-10 depict the phenotypic variability among the backcross progeny of Brood 1. Figures 6-9 are females, whereas Figure 10 is a male. Four of these specimens (Figures 6, 7, 8, and 10) exhibit the darkened (brownish) forewings and light orange hindwings of the wild-caught Lanoraie specimen described above. The backcross specimen in Figure 8 closely resembles the Lanoraie specimen phenotype.



Representatives of “hybrid-like” versus “parent-like” backcrosses from Brood 2 (Figures 11-15) indicate the wide range of phenotypic variability occurring within this brood. Figure 11 is a male with “arthechippus”-like forewings and *L. archippus*-like hindwings, again showing close phenotypic similarity to the presumed female backcross specimen from Quebec. Figures 13 and 14 are “lighter” and “darker” “rubidus”-like specimens closely resembling their F<sub>1</sub> hybrid male parent. Other Maryland F<sub>1</sub> hybrid crosses not illustrated in this paper involved the partially banded intergrade form of the *L. arthemis-astyanax* complex (*L. arthemis proserpina* Edwards x *L. archippus*). Such crosses produced the “arthechippus” and “rubidus” hybrids as siblings, in a 1:1 ratio (Platt 1987).

**Table 2. Laboratory backcross matings<sup>1</sup> of Maryland *Limenitis archippus* females with F<sub>1</sub> hybrid “arthechippus” and “rubidus” males.**

Brood Number and Date Reared	“P <sub>1</sub> Male Phenotype” and Cross Type	Sex <sup>2</sup>	Backcross Progeny Phenotype				Totals
			Hybrid-like		Parent-like ( <i>Limenitis archippus</i> )		
			“arthechippus”	“rubidus”	Narrow Medial White Bar Present on Dorsal Hindwings	Only Medial Black Bar Present on Hindwings	
Brood 1 June 1977	“arthechippus”	male	13	0	16	21 <sup>3</sup>	50
	Maryland	female	6	0	16	4	26
	<i>L. archippus</i> ♀						
	x						
	Vermont						
	<i>L. a. arthemis</i> ♂						
Brood 1 Subtotals			19	0	32	25	76
Brood 2 Sept 1983	“rubidus”	male	7 <sup>3</sup>	7 <sup>3</sup>	0	4	18
	Maryland	female	0	2	0	2	4
	<i>L. archippus</i> ♀						
	x						
	Maryland						
	<i>L. a. asryanax</i> ♂						
Brood 2 Subtotals			7	9	0	6	22
Broods 1 and 2 Combined		male	20	7	16	25	68
		female	6	2	16	6	30
Broods 1 and 2 Grand Totals			26	9	32	31	98

<sup>1</sup>The crosses involve *Limenitis* strains originating from the following localities (by species and forms): *L. archippus* = Anne Arundel, Baltimore, Cecil and Frederick Counties, Maryland; *L. arthemis arthemis* = Addison County, Vermont; *L. arthemis astyanax* = Allegany, Baltimore and Cecil Counties, Maryland.

<sup>2</sup>Both broods and the combined data exhibit statistical deficiencies of females (see far right column), as follows for data: Brood 1:  $\Sigma\chi^2_1$  (Yates Correction) = 7.70<sup>\*\*</sup>; Brood 2;  $\Sigma\chi^2_1$  (Yates Correction) = 9.38<sup>\*\*</sup>; Broods 1 and 2 combined:  $\Sigma\chi^2_1$  (Yates Correction) = 14.90<sup>\*\*</sup>. (<sup>\*\*</sup> statistically significant at the 1% level)

<sup>3</sup>Progeny in these groups could be further divided into 1:1 ratios between “lighter” (more orange *archippus*-like) and “darker” (more brownish-black *arthemis-astyanax*-like) morphs; several represent intermediates, with darker forewings and lighter hindwings (see Figures 6-15).





**Figures 6-10. Laboratory-bred “hybrid-like” and “parent-like” sibling specimens from the 1977 backcross of a female *L. archippus* and an F<sub>1</sub> hybrid “*arthechippus*” male (Brood 1):** **6)** 915-1 female, 11 June, typical hybrid “*arthechippus*” morph.; **7)** 915-40 female, 12 June, “hybrid-like” morph having darkened forewings with orange “*archippus*-like” hindwings expressing the dorsal iridescent white medial bar sandwiched between inner and outer melanized black lines; **8)** female 915-41, 12 June, “intermediate” morph possessing darkened (hybrid-like) forewings but light orange (parent-like) hindwings, with the single black medial bar characteristic of *L. archippus*. (This specimen and the male shown in Figure 11 are similar to the flight-worn, presumed backcross specimen in Figure 5); **9)** 915-18 female, 11 June, “parent-like” (*L. archippus*) backcross specimen; **10)** 915-35 male, 12 June, unique phenotype possessing both darkened (orange-brown) forewings and hindwings, but otherwise “parent-like.” (This darkened form did not show up among the females of this brood.)



**Figures 11-15. Laboratory-reared “hybrid-like” and “parent-like” sibling specimens from the 1983 backcross of a female *L. archippus* and an  $F_1$  hybrid “rubidus” male (Brood 2):** 11) 1050-21 male, 17 September, light (orange) “arthechippus”-like hybrid morph; 12) 1050-3 male, 10 September, dark (orange-brown) “arthechippus”-like hybrid morph; 13) 1050-8 male, 1 September, light (orange) “rubidus”-like hybrid morph; 14) 1050-7 male, 11 September, dark (orange-brown) “rubidus”-like hybrid morph; 15) 1050-10 female, 10 September, “parent-like” specimen. The “arthechippus” and “rubidus” hybrid-like siblings appeared in a 1:1 ratio in this brood (Table 2). (The general appearance of the male in Figure 11 again is suggestive of the presumed backcross female shown in Figure 5.)

## DISCUSSION

Although further data are lacking from the label, the second early hybrid “*rubidus*” specimen shown in Figure 3 undoubtedly is the same one referred to in the following paragraph recorded by Edwards (1884: 208-209).

“Mr. Robert M. Grey, residing at Kenwood, near Albany, writes that he has taken examples of *Proserpina* three miles below Albany in company with *Ursula* [= *astyanax*]. ... Mr. Grey states further that he has taken *Proserpina* in the Heldeberg Mountains, fifteen miles back [= southwest] of Albany, in company with *Arthemis*. ... With the examples sent by Mr. Grey was a very interesting one of *Disippus* (= *archippus*), considerably melanized, so that there was sufficient approach to the black species to suggest hybridism between the two.”

There are, of course, several other examples of this hybrid form known from early collections (see Holdridge 1899 and Platt et al. 1978). Most of these are currently deposited either in the MCZ, at the AMNH, or at the USNM. Several others, including Strecker’s “type” of hybrid “*rubidus*” are in the FMNH. The R. M. Grey specimen (Figure 3) quite likely represents the same eastern New York record which Shapiro and Biggs (1968) and Platt et al. (1978) suggested may have been collected in the Catskill Mountains.

The hybrid form “*rubidus*” seems to occur in nature more regularly than do the other *L. archippus*-related hybrids (Elder 2000; Ross and Marks 2002). There are at least 60 records of this form either seen or collected in the wild “prior to 1872” through 2011 (Platt and McClanahan 2003; Platt, unpublished data; James Vaughn, in litt.). The form is widely distributed from Massachusetts, Michigan, Wisconsin, Missouri, Kansas, and Nebraska in the north, to Florida, Mississippi, Texas and Arizona in the south. Rare specimens of “*rubidus*” have been collected in 24 states and the District of Columbia. Three of these wild hybrids (from Delaware, North Carolina, and New Mexico) are in the Platt Collection at MGCL/FLMNH.

Viceroy butterflies are, in fact, Müllerian (rather than Batesian) mimics of Monarchs, *Danaus plexippus* Linnaeus (Nymphalidae), (Ritland and Brower 1991, 2000; Ritland 1995, 1998). Viceroy’s have been shown to contain three phenolic glycoside compounds (salicin, salicortin, and tremulacin) sequestered from their willow and poplar larval food plants (Salicaceae) (Prudic et al. 2007a). These chemicals presumably impart a bitter taste to the butterflies, making them unsuitable prey for many of their potential predators. Finally, Prudic and Oliver (2008) have suggested that the disruptively banded northeastern form of Nearctic admiral (*L. arthemis arthemis*) has evolved in very recent times from its more southern unbanded mimetic form (*L. a. astyanax*), rather than the other way around, as has long been assumed. If shown to be true, this hypothesis may help to explain why the eastern admiral forms lack the white band and cream-colored, melanin-related pigment of the two western American admiral species.

Recently, Mr. James Vaughn (in litt.) of Dexter, Missouri digitally color-photographed four additional wild male hybrid “rubidus” in Stoddard (N=3) and Dunklin (N=1) Counties in very southeastern Missouri. These insects represent at least three, (and most likely four) different hybrid pairings between *L. archippus* and *L. arthemis astyanax* males and females. All of them appeared to be fresh specimens. They were observed between mid-August and mid-October (with a mean date of 8 September 2010). Thus, they again represent late summer to early fall pairings. Vaughn’s observations suggest another “hybrid swarm” locality in this region. Since these hybrid males were not collected, they could possibly have courted and even bred with either *L. archippus* or *L. arthemis astyanax* females during their lifetimes. The Vaughn photographs can be viewed on the Butterflies and Moths of North America (BAMONA) website (Opler et al. 2011).

### HABITAT PREFERENCES AND HYBRIDIZATION

Although Nearctic *Limenitis* generally breed within their own species, under certain circumstances and environmental conditions, either allopatric or sympatric populations are capable of interspecific hybridization. Such hybridization often is restricted both spatially and temporally. Among the forms and species, *L. arthemis astyanax*, *L. weidemeyerii*, and *L. lorquini*, hybridization usually occurs along the peripheral margins and edges of their allopatric geographic distributions. On the other hand, *L. archippus* is broadly sympatric with the other butterflies, and it favors more open, moist meadows and lowland fields and swamps, whereas the other species are likely to be found along upland dirt roadways and in habitats containing woodland margins and groves of alder, *Alnus* Mill. spp. (Betulaceae); aspen, *Populus* L. spp. (Salicaceae); and willow, *Salix* L. spp. (Salicaceae); especially if such regions contain woodland or mountain streams, springs, or bogs. Much of the natural interspecific hybridization reported between *L. archippus* and its congeners occurs late in the flight season (August – November), except in Florida (Platt et al. 1978; Ritland 1990). Often this cross-breeding occurs when one of the species is rare compared to the other (e. g., individuals from small populations may be more aggressive in seeking mates among individuals of other species). However, in certain localities known as hybrid “hotspots,” a few of these rare hybrids may occur year after year (Ritland 1990; Covell 1994; Platt and Maudsley 1994).

The muskeg habitat from which the female presumed backcross specimen was captured is similar to a collecting site at Passadumkeag (Penobscot County) in northern Maine (Klots 1951) where L. Paul Grey collected an F<sub>1</sub> hybrid “arthechippus” of the “second brood” “many years ago” (L. P. Grey 1968). This habitat also may closely approximate the Chateauguay Basin (Quebec) locality where J. G. Jack collected Scudder’s “type” specimen of this form (Figure 1).

### EVOLUTIONARY IMPLICATIONS

R. M. Grey (1879) speculated that *L. arthemis arthemis*, *L. arthemis astyanax*, and *L. archippus* might merely represent different forms of a single polytypic species. While *L. a. arthemis* and *L. a. astyanax* have continued to completely intergrade since his time, there can be no doubt that the interspecific crossing involving *L. archippus* is both



extremely rare and localized. *L. archippus* is phenotypically and behaviorally quite distinct from the two former butterflies, and the distal ends of its male valvae are comparatively highly modified into sickle-shaped recurved spines (Platt et al. 1970).

Only ten observed or wild-caught specimens of banded *L. arthemis* spp. x *L. archippus* have ever been recorded in the literature (Platt et al. 1978), along with one natural mating of a female *L. archippus* to an *L. arthemis* male (Covell 1994) which occurred in August 1988 in northern Wisconsin. The evidence presented in this paper suggests strongly that the female specimen depicted in Figure 5 resulted from the natural backcross mating of an *L. archippus* female to an interspecific F<sub>1</sub> hybrid “*arthechippus*” male. Such rare hybrid butterflies are known to have been collected from similar sphagnum/black spruce bog (or muskeg) habitats. *L. archippus* and *L. a. arthemis* are the only two species of admirals that commonly occur in the Lanoraie locality from which the presumed backcross specimen was collected.

Two other Quebec specimens (both of *L. arthemis arthemis*) were donated to the Allyn Museum of Entomology along with the presumed backcross female, as part of the F. H. Chermock collection. The first one was taken at Shawbridge, Quebec on 27 June 1937, most likely by the same unknown collector since the hand-written inked data labels are the same on both specimens. The second *L. a. arthemis* was collected at Montreal, Quebec in June 1916 by J. A. Corcoran.

The dorsal wing surfaces of the backcross specimens in Figures 6-15 suggest why the Viceroy phenotype possesses the central medial black band across its hindwings: specimens in Figures 6 and 7 possess narrow remnants of the ancestral iridescent white bands of *L. a. arthemis* sandwiched between the thin basal and more marginal, melanized black lines. The central hindwing white band remnant is a non-mimetic feature of the model Monarch. By bringing these two narrow melanin fronts together, this non-mimetic dorsal feature is eliminated (as shown in Figures 8-15). Although the central black line persists on the Viceroy’s hindwings, it does not seem to detract significantly from the Viceroy’s mimetic resemblance to its model (Platt et al. 1971).

## CONCLUSIONS

In interspecific F<sub>1</sub> hybrids, the genes of two separate species are combined to yield “evolutionary intermediate” phenotypes. In crosses involving the Viceroy and its congeneric forms, virtually all of the locally produced natural F<sub>1</sub> hybrids are males. The heterogametic (ZW) females are “lost” during various egg, larval, and pupal stages of development, and usually do not survive to become adults (See Platt and Harrison [1994] for a single lab-bred exception to this generality.). Among Viceroy’s, the partial expression of the white banding has become canalized in order to “fix” the insect’s wing pattern for its closest approach to that of its model, the Monarch, thus further enhancing the mimetic resemblance between the two different species.

The possibility exists that the Lanoraie specimen (Figure 5) merely represents a mutant female, in which the forewing ground color has become darkened, thus, by coincidence resembling the “arthechippus” phenotype. Both pale buff-colored and completely patternless Viceroy's are known in museum and private collections, and Platt (1983) illustrated in color a female collected near York (York County), Pennsylvania, in which the medial white banding is expressed more fully than normal. The forewings of this latter insect are a dark sooty black, except in the costal and basal wing regions, and in enlarged areas expressing the sub-marginal red-orange spots. However, its patterns are completely unlike those of the Lanoraie specimen.

Remington (1958) further notes that among certain peripheral geographical subspecies of Viceroy's (*L. archippus floridensis* Strecker and *L. a. watsoni* [dos Passos]), the forewing ground color tends to be darker than that of the hindwings. In fact, it even is possible that the latter subspecies (*L. a. watsoni*) could have arisen from either interspecific (or subspecific) backcrossing of the type postulated to have taken place years ago in Quebec. The occurrence of the similar pattern in the Lanoraie specimen resulting from hybrid backcrossing seems a far more likely explanation than that it arose through a series of macro-mutations, in view of the supportive laboratory evidence that such crosses produce female progeny with very similar phenotypes. The habitat from which the purported backcross female was collected is conducive to such interspecific hybridization. The fact that such backcrosses are possible genetically, and that they can yield nearly identical female phenotypes, have both been experimentally demonstrated in the laboratory.

Interspecific hybridization, especially when combined with backcrossing by the hybrids themselves, provides a mechanism by which genes can be transferred between closely related species, and perhaps even can be passed on to future generations. However, in *Limenitis*, such backcrosses invariably exhibit disrupted sex ratios and lower viability than do offspring of intraspecific matings (Platt 1975, 1983). The fact that this much worn “backcross” female had not mated prior to her capture suggests that she was at a selective disadvantage herself, which ultimately produced a “dead end” to her lineage.

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**An August Survey of Wild Bees (Hymenoptera: Apoidea) in the Northeastern Port Areas of Baltimore, Maryland and the Second North American Record of *Pseudoanthidium nanum* (Mocsáry) – Addendum**

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Subsequent to the publication of Droege and Shapiro (2011), Jason Gibbs published a revision of the *Lasioglossum* (*Dialictus*) species of eastern North America (Gibbs 2011). In that revision, he formally described what we had called “*Lasioglossum* species #2.” That specimen keyed out to the new species *Lasioglossum trigeminum* Gibbs, 2011. The specimen was also compared to material identified by Jason Gibbs as *Lasioglossum trigeminum*.

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## **Bees (Hymenoptera: Apoidea) of the Dominion Cove Point Liquefied Natural Gas Facility and Vicinity, Calvert County, Maryland – Addendum**

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In our recent article reporting results from a bee survey in Calvert County, Maryland (Shapiro and Droege 2011), we included in our tabulations a specimen we referred to as “*Lasioglossum* species #1” and noted that this species would soon be formally named by Jason Gibbs in his revision of the *Lasioglossum* (*Dialictus*) species of eastern North America (Gibbs 2011). This species has now been formally described as *Lasioglossum gotham* Gibbs, 2011.

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## First Maryland Record for a Rare Slave-making Ant, *Temnothorax duloticus* Wesson (Hymenoptera: Formicidae: Myrmicinae)

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Socially parasitic myrmicines, whether they are dulotic (slave makers) or inquilines (guests), are, at the very most, uncommon. Most are very rare with spotty geographic and temporal distributions (Hölldobler and Wilson 1990). One species, *Monomorium pergandei* (Emery), a workerless inquiline discovered in the nest of *Monomorium minimum* (Buckley), has not been reported again since its discovery in Washington, DC, 120 years ago. In Maryland, at least two socially parasitic species are known to occur: *Protomognathus americanus* (Emery), a dulotic species which occurs in mixed colonies with its host, one of three species of *Temnothorax*: *T. curvispinosus* Mayr, *T. longispinosus* Roger, and *T. ambiguus* Emery; and *Anergates atratulus* (Schenck), an inquiline which occurs in the nest of *Tetramorium caespitum* (Linnaeus). I suspect that several other species may occur in the state, but because of the nature of their biology, even intensive surveys in a suspected area are very likely to turn up empty. This article documents the discovery of a previously unrecorded species.

On 31 August 2011, I traveled to the Morgan Run Natural Environment Area (Morgan Run), Carroll County, Maryland to collect a mixed colony, consisting of *T. curvispinosus* workers enslaved by *P. americanus*. I had collected *P. americanus* from various localities in the state previously, but the Carroll County site in the past had consistently produced mixed colonies of these two species. My main objective was to obtain males in hopes of producing a generic key to the male ants occurring in Maryland. I wanted to maintain the mixed colonies throughout the year and collect males that might emerge the following year. Morgan Run was an hour's drive from Baltimore, where I worked, and I had at most two hours of collecting before it would become too dark.

The habitat at Morgan Run is a dry piedmont oak-dominated hardwood forest with sparse understory vegetation on rocky soil. When I arrived at the site I noticed that the forest floor, normally with patches of bare ground, was completely carpeted with dead leaves and fallen branches. The abundance of fallen plant material was due to the remnants of Hurricane Irene which had passed through the area weeks earlier. At Morgan Run, I most often find *T. curvispinosus* in old acorns possessing a circular opening. These acorns had been previously utilized by a larva of a weevil (Coleoptera: Curculionidae) or some other insect which consumed the interior of the nut before chewing an exit hole to pupate elsewhere. *Temnothorax* utilizes these abandoned hollow acorns. Usually it is not difficult to find these colonies, but due to the abundance of wind-blown plant material, finding any colony, let alone a mixed one proved to be quite challenging in the time I had to collect. A colony consisting of *T. curvispinosus* and *P. americanus* is easy to recognize at first view because even though both species are roughly the same size, their coloration is very different. *Protomognathus americanus* (Figure 1) is a very dark brown ant, whereas *T. curvispinosus* (Figure 2) is a much lighter yellowish brown. This

is not the case with *T. longispinosus* (Figure 3), also a very dark colored species, and a closer examination is necessary to determine whether a mixed colony is present in this instance.



**Figure 1. *Protomognathus americanus* (Emery).** Morgan Run, Carroll County, Maryland. 13 June 2008.



**Figure 2. *Temnothorax curvispinosus* Mayr.** Morgan Run, Carroll County, Maryland. 31 August 2011.



**Figure 3. *Temnothorax longispinosus* Roger.** Morgan Run, Carroll County, Maryland. 15 June 2007.

During the first hour, only one *T. curvispinosus* colony was discovered, and *P. americanus* was not present. Near the end of the second hour, it was becoming harder to see and I started working back to the car, stopping along the way to inspect acorns for exit holes. I spotted a cluster of four acorns, one of which contained a hole. When opened, another *T. curvispinosus* colony was discovered, but some of the workers appeared slightly more robust and darker than others. I decided to collect this colony, even though I knew it contained no *P. americanus*. I considered the possibility that I may be looking at *Temnothorax duloticus* Wesson, and I wanted to verify this once I got home. At home the specimens were viewed under a stereomicroscope, confirming that I indeed had a mixed colony consisting of three species. The colony consisted of 100 specimens: 76 *T. curvispinosus* workers; 1 *T. longispinosus* worker; and 23 members of *T. duloticus* (Figure 4) (21 workers; 1 nest queen; and 1 alate female).

Maryland now becomes the third state where *T. duloticus* is known to occur. This species was first described in Ohio (Wesson 1937), where the majority of collection records occurs, and has also been reported from Michigan (Wheeler et al. 1994). It may possibly occur in Illinois (Talbot 1957), although its occurrence there was questioned, in part because it was not found in an Illinois survey (Coovert 2005). Considering this recent discovery in Maryland, it is not unreasonable to think that it might turn up in Illinois. A couple of years earlier, I believed that *T. duloticus* might be present in Washington County, Maryland, and unsuccessfully searched for it at Greenbrier State Park. Instead it turned up at Morgan Run, but only after six years of collecting ants from this site.

*Temnothorax duloticus* very closely resembles *T. curvispinosus* (Figure 5). When compared side-by-side, *T. duloticus* has a more robust build and tends to be a darker yellowish brown. The antennae consist of 11 segments in *T. duloticus*, 12 segments in *T. curvispinosus*. The post-petiole is also broadly attached to the abdomen in *T. duloticus* and the abdomen has small appressed hairs in addition to the larger erect hairs. These features are absent in *T. curvispinosus*.

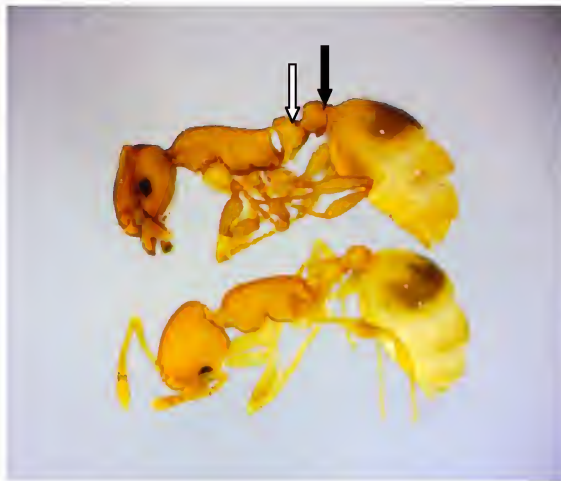
The impact of dulotic ants upon their host populations varies with each species and locations, but generally the effect is negative (Brandt et al. 2005). The impact of two dulotic species in the same locality depends to a significant extent on which species is more numerous. At Morgan Run, *P. americanus* greatly outnumbered *T. duloticus*, and abundant *Temnothorax* colonies are present. This observation agrees with previous field observations (Johnson and Herbers 2006), where *P. americanus* is the more common of the two. If *T. duloticus* was the more common or the only slave-maker present, a significant reduction of viable host colonies would occur. A contributing cause for the different fates of host colonies is the way each of the invaders acquire slaves.

*Protomognathus americanus* workers usually induce panic to the opposing host workers by repeated "bouncing" or rough handling, although workers are sometimes killed in the process (Creighton 1950; Hölldobler and Wilson 1990). Once panicked, host workers flee from the scene with some of their brood; *P. americanus* workers then transport the remaining abandoned brood back to the nest. The raided colony relocates to a new site and resumes brood production and rearing. Since host colony mortality is minimized, the population in a given area remains relatively stable. In contrast, *T. duloticus* often kills

opposing workers during brood appropriation raids and subsequent raids over time result in localized extinction of host colonies. Enclosed field experiments (Johnson and Herbers 2006) in which both dulotic ants were given access to the same host, *T. duloticus* tended to eliminate *P. americanus* from the area. Thus, it is theoretically possible at Morgan Run for *T. duloticus* to become the dominant of the two dulotic species over a period of time. Such long-term field studies on two-parasite, one-host systems among ants are lacking.



**Figure 4. *Temnothorax duloticus* Wesson.** Arrow points to the fine appressed hairs characteristic of this species. Morgan Run, Carroll County, Maryland. 31 August 2011.



**Figure 5. *Temnothorax duloticus* (top) and *T. curvispinosus* (bottom) for comparison.** Note that *T. duloticus* has a relatively robust build, darker coloration, and a thick petiole (white arrow) and post-petiole (black arrow). Morgan Run, Carroll County, Maryland. 31 August 2011.

While the discovery of *T. duloticus* in Maryland was fortuitous, on that day I did not obtain the species I went to collect. One week later on 7 September 2011, I returned to Morgan Run. This time I was successful in obtaining *P. americanus*. I collected three colonies, and a fourth colony, upon closer examination, turned out to be a colony fragment consisting of two *T. duloticus* workers along with workers of the two host *Temnothorax* species. The colony, likely a satellite colony, is currently being maintained, along with the other mixed colonies collected at the time.

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## Associations of Ants (Hymenoptera: Formicidae) on Oaks and Pines in Inland Dune and Ridge Woodlands in Worcester County, Maryland

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**ABSTRACT:** Inland dune and ridge woodlands represent a rare community type largely restricted to the Delmarva Peninsula. Shortleaf pine (*Pinus echinata* Mill.) exhibits a restricted distribution in Maryland and is often a dominant component of these woodlands. It is also likely to represent one of the geologically oldest tree components in these communities. We compared the overall species composition of ants (Hymenoptera: Formicidae) on shortleaf pine, loblolly pine (*P. taeda* L.), and various species of oaks (*Quercus* L. spp.) to determine whether there were any ant species restricted to or preferentially associated with shortleaf pine. Ants were sampled using hand collection methods from 241 trees representing a mix of these three groups. Multiple-response permutation procedure (MRPP) revealed a marginal difference between the three groups. Systematic group exclusion revealed a marginally significant difference between oaks and loblolly pine, a non-significant difference between loblolly and shortleaf pines, and a significant difference between oaks and shortleaf pine. Indicator species analysis (ISA) showed that three ant species were associated with oaks while one species was associated with loblolly pine. Of the 35 species that were collected, none showed an association with shortleaf pine.

## INTRODUCTION

Inland dune and ridge woodlands (Figure 1) are globally rare natural communities occurring only on the Delmarva Peninsula and in southern New Jersey (NatureServe 2012). These communities feature low-relief inland dunes shaped by northwest winds during the Pleistocene epoch (Newell and Dejong 2011) and are comprised of dry sandy soils of the Parsonsbury Formation (Denny et al. 1979; Newell and Dejong 2011). They are dominated by shortleaf pine (*Pinus echinata* Mill.), loblolly pine (*P. taeda* L.) and oaks (*Quercus* L. spp.), most commonly southern red oak (*Q. falcata* Michx.), water oak (*Q. nigra* L.), and black oak (*Q. velutina* Lam.) (Harrison 2004). Shortleaf pine exhibits a restricted distribution in Maryland growing only in areas with well-drained, nutrient-poor soils (Little 1971) and achieving dominance only in dune and ridge woodlands on the Delmarva Peninsula. On the Delmarva, however, it has been largely or completely displaced in many dune and ridge woodland sites by loblolly pine, a preferred species for commercial timber production. Some loblolly-dominated stands result from natural regeneration of previously harvested stands while others were planted for commercial timber production, many over a century ago (Maryland Department of Natural Resources – Forest Service, unpublished site data). Shortleaf pine stands result from natural regeneration and remain a key component of dune and ridge woodlands.



**Figure 1: Typical dune and ridge woodland, Worcester County, Maryland. Location near Snow Hill, 26 October 2009.**

Shortleaf pine is considered to be the most cold-hardy species of the southern pines and likely existed in a continuous distribution across the continental shelf, whereas loblolly pine persisted in southern Texas and northern Mexico refugia during the Pleistocene, expanding its range north only after the glaciers receded (Schmidtling 2007). Shortleaf pine was therefore likely persistent in Maryland long before other pine species migrated there or were planted, and is probably one of the geologically oldest tree components of dune and ridge woodlands on the Delmarva Peninsula. Its historical distribution and persistence may have allowed for the evolution of specialized relationships between shortleaf pine and invertebrates, many of which are dependent on trees for nesting, foraging, and for temporary refuge (Büchs 1990; Simon 1991; Hanula and Franzreb 1998; Majer et al. 2003). In addition to its long-term presence in these communities, specific characteristics of the bark and the presence or absence of potential competitors or predators on shortleaf pine may also impact the invertebrate assemblage it supports. Characteristics such as these have been demonstrated to influence the invertebrate fauna supported by different tree species in other studies (Nicolai 1993; Majer et al. 2003; Verble and Stephen 2009). To our knowledge, there are no published studies on the associations of ants (Hymenoptera: Formicidae) and shortleaf pine, even in the southern United States where shortleaf pine is more abundant.

Our study sought to determine whether there were any ant species in dune and ridge woodlands on the Delmarva Peninsula that were restricted to or preferentially associated with shortleaf pine. We also compared the overall species composition of ants on shortleaf pine, loblolly pine, and oak and compiled a list of ants associated with pines and oaks in this natural community.

## METHODS

The study area encompassed 30 dune and ridge woodland sites in Worcester County, Maryland. All 30 sites were within two adjacent United States Geological Survey (USGS) quadrangles, Snow Hill and Dividing Creek. Sites differed in their historical management practices, in forest stand age, and in tree species composition.

To locate dune and ridge woodland sites, which are typically interspersed throughout a landscape of basin swamp and lowland forest, we used a combination of USGS quadrangle (topographic) maps and two ArcMap GIS (geographic information system) software data layers: United States Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) data, and LIDAR (Light Detection and Ranging) imagery. Characteristics of dune and ridge woodlands include an increase in elevation as compared to the surrounding forest matrix, an elliptical shape, and well-drained soil series, each of which can usually be ascertained using these resources. Potential dune and ridge woodlands were mapped as polygons in both quadrangles using ArcMap, and then 30 of those sites were chosen at random for this study. All sites were ground-truthed to verify that the polygons did indeed represent dune and ridge woodland habitat.

Surveys of ants were conducted in June and August in 2008 and 2009 from trees at all 30 sites. Since we could not control for differences in management, stand age, or tree species composition, we sampled a consistent number of pines and oaks from all 30 sites. Each site fell into one of three habitat size classes (i.e., dune area): small ( $< 1.1$  ha [ $2.7$  ac]), medium ( $1.1 - 4.0$  ha [ $2.7-9.9$  ac]) and large ( $> 4.0$  ha [ $9.9$  ac]). Six trees were sampled at each small site, 9 trees at each medium site, and 12 trees at each large site. All trees were selected at random, with the condition that they have a minimum diameter of 6 cm (2.4 in) and be a minimum distance of 10 m (32.8 ft) from any other surveyed tree. In most cases, an equal number of shortleaf pines, loblolly pines, and oaks were sampled at each dune. When this was not possible (i.e., if no shortleaf pine was represented at a site), the same number of trees was sampled given the size class of the site but the ratio of tree species was adjusted.

We surveyed for ants using 15-minute sampling periods per tree, between 1000 and 1600 hours. Investigators collected all ants observed within that time period with an aspirator. Each tree was sampled only once and all collections were made from the lower 2 m (6.6 ft) of the trunk. Multiple investigators sampled trees at each dune and ridge woodland site. In order to reduce collector bias, investigators were required to survey multiple tree species at each site (so that one person wasn't continuously sampling the same tree species).

Ants were identified in-house using multiple resources (Lynch 1987; Johnson 1988; Snelling 1988; Coovert 2005; Trager et al. 2007; LaPolla et al. 2010). Species identifications were verified by referencing specimens at the Smithsonian Institution's National Museum of Natural History (USNM) and through consultation with local entomologists. Taxonomy follows the "working list" as described by Fisher and Cover (2007).

We used multiple-response permutation procedure (MRPP), a nonparametric analog of analysis of variance, to test the null hypothesis of no significant differences in ant species composition between shortleaf pine, loblolly pine, and oaks. Details of the method may be found in Mielke and Berry (2001); the program we used is employed in PC-ORD (v. 3.04, MjM Software, Gleneden Beach, Oregon). The strategy of MRPP is to compare the observed intragroup average distances with the average distances that would have resulted from all the other possible combinations of the data under the null hypothesis. The test statistic, usually symbolized with a lowercase delta,  $\delta$ , is the average of the observed intragroup distances weighted by relative group size. The observed delta is compared to the possible deltas resulting from every permutation of the data. The MRPP reports a test statistic (T) describing the separation among groups; a measure of effect size (A) describing within-group agreement; and a p-value representing the likelihood of finding an equal or smaller delta than the observed based on all possible partitions of the data set using the Pearson Type III distribution of deltas. We used Sorenson distance and a ranked distance matrix following the protocols in McCune and Grace (2002). We used indicator species analysis (ISA) as a complement to MRPP to describe the value of different ant species for indicating each group of trees. Indicator values range from zero (no indication) to 100 (perfect indication). We evaluate statistical significance of indicator values by a Monte Carlo method using 1000 randomizations. The null hypothesis is that the observed maximum indicator value  $IV_{max}$  is no larger than would be expected by chance. Species that occurred fewer than three times were excluded from the analysis. A Spearman's correlation was conducted using an online calculator (Wessa 2012) to determine whether tree diameter had any influence on the results of the ISA.

## RESULTS

A total of 241 trees were surveyed at the 30 sites: 77 shortleaf pines, 83 loblolly pines, and 81 oaks. The breakdown of oaks sampled is as follows: 12 *Quercus alba* L. (white oak), 21 *Q. velutina*, 23 *Q. falcata*, 16 *Q. nigra*, and 7 *Q. stellata* Wangenh. (post oak). For two trees the species of oak was not recorded.

Ten species of ants were excluded from the analysis because they occurred fewer than three times. These were *Aphaenogaster treatae* Forel, *Camponotus caryae* (Fitch), *Camponotus subbarbatus* Emery, *Crematogaster pilosa* Emery, *Forelius pruinus* (Roger), *Myrmecina americana* Emery, *Myrmica punctiventris* Roger, *Pyramica rostrata* (Emery), *Temnothorax ambiguus* (Emery), and *Trachymyrmex septentrionalis* (McCook).

The final MRPP data matrix comprises 25 ant taxa x 241 trees. The results indicate an overall marginal difference between the three groups ( $p = 0.067$ ). The results of systematic group exclusion are illustrated in Table 1 and show no difference between



loblolly and shortleaf pine ( $p = 0.749$ ), a marginal difference between oak and shortleaf pine ( $p = 0.052$ ) and a significant difference between oak and loblolly pine ( $p = 0.026$ ).

**Table 1. Results of Multi-Response Permutation Procedures (MRPP) for ant species on trees.** The first line is the overall multivariate comparison; subsequent lines compare pairs of groups. Analysis is based on a rank-transformed Sorenson distance matrix comprising 25 ant taxa x 241 trees. (T) describes the separation among groups, (A) is a measure of effect size describing within-group agreement, and (p) is the probability of finding a higher value of T in all permutations of the data. Significant p values are in bold.

Groups	T	A	p
Overall	-1.640	0.006	0.067
Oak vs. Shortleaf	-1.860	0.008	0.052
Oak vs. Loblolly	-2.425	0.010	<b>0.026</b>
Shortleaf vs. Loblolly	0.732	-0.003	0.749

Indicator species analysis (Tables 2 and 3) detected four ant species as indicators. *Aphaenogaster mariae* Forel ( $p = 0.003$ ), *Camponotus pennsylvanicus* (DeGeer) ( $p = 0.005$ ), and *Prenolepis imparis* (Say) ( $p = 0.017$ ) all occurred with greater abundance and frequency on oaks, while *Crematogaster ashmeadi* Mayr ( $p = 0.018$ ) occurred with greater abundance and frequency on loblolly pine.

Spearman’s correlation showed no relationship between tree diameter and the number of ants collected per tree ( $r = 0.06$ ,  $df = 236$ ) or between tree diameter and the number of ant species collected per tree ( $r = 0.08$ ,  $df = 236$ ). Three trees were excluded from the analysis because the diameter was not recorded.

DISCUSSION

The MRPP analysis suggests that different tree species support different suites of ant species. The overall p-value ( $p = 0.067$ ) approaches but does not support rejecting the null hypothesis at the traditional  $p < 0.05$  level. While the difference between oaks and pines is apparent, no significant differences were detected between the different pine species. We found no evidence that the arboreal or trunk-using ants in our dune and ridge woodland sites have evolved a preferential relationship with shortleaf pine. In the few cases where an ant species demonstrated a higher occurrence on one species group over another, the preference was usually for oak. Since a pool of five oak species was sampled for ants, there could be additional partitioning of the ants per oak species, but that association was not investigated. Only *C. ashmeadi* showed a preference for loblolly pine, although it was also found on both shortleaf pine and on oak (Table 2).

Results of the ISA should be viewed with caution, as some of the significant results are based on the presence of a species with low numbers of observations (from sometimes very few trees). *Camponotus pennsylvanicus*, for example, was observed only six times on a total of five trees (Table 2). While it can nest in rotted tree cavities and is known to forage on tree trunks, it is not truly arboreal (Coovert 2005) and may be better sampled

using alternate survey techniques. In general, *Camponotus* species were collected very infrequently using timed hand collection methods. Therefore, despite the p-value, the inferred preference for oak may not be reliable. The same is probably true of *P. imparis*, known soil nesters that often forage on trees (Lynch 1987, Coovert 2005). Large numbers of workers have been observed to concentrate at food sources, including sap running from tree wounds (Lynch 1987). This could impact our results, as it may be available food resources that influence its presence and not necessarily tree species. We may also have underestimated the presence of this ant, as both Lynch (1987) and Coovert (2005) indicate a lull in activity during the summer months, when we conducted our surveys.

**Table 2. Results of the Indicator Species Analysis (ISA) showing the relative abundance of ants found on the three different tree groups.** Values range from 0% (no indication) to 100% (perfect indication). The table also shows the total number of ants collected for each species (Individuals Collected), and the number of individual trees from which each species was collected (Trees with Ants). (Because relative abundance values are rounded to whole numbers, the sum per individual species may range from 99 to 101.)

Species	Individuals Collected	Trees with Ants	Relative Ant Abundance (%)		
			Oak (N=81)	Loblolly (N=83)	Shortleaf (N=77)
<i>Aphaenogaster fulva</i> Roger	46	11	11	56	34
<i>Aphaenogaster lamellidens</i> Mayr	205	77	40	36	24
<i>Aphaenogaster mariae</i> Forel	58	10	83	17	0
<i>Aphaenogaster rudis</i> Enzmann	121	72	35	22	43
<i>Camponotus castaneus</i> (Latreille)	6	6	50	33	18
<i>Camponotus chromaiodes</i> Bolton	11	7	18	26	56
<i>Camponotus nearcticus</i> Emery	14	13	36	42	23
<i>Camponotus pennsylvanicus</i> (DeGeer)	6	5	100	0	0
<i>Camponotus snellingi</i> Bolton	8	6	62	12	26
<i>Crematogaster ashmeadi</i> Mayr	452	68	13	57	30
<i>Crematogaster cerasi</i> (Fitch)	4	3	49	0	51
<i>Crematogaster lineolata</i> (Say)	96	45	33	30	37
<i>Formica pallidefulva</i> Latreille	11	9	36	26	38
<i>Formica subsericea</i> Say	16	6	69	18	13
<i>Lasius alienus</i> (Foerster)	31	3	73	0	27
<i>Monomorium minimum</i> (Buckley)	30	5	0	22	78
<i>Myrmica americana</i> Weber	4	3	75	25	0
<i>Nylanderia faisonensis</i> (Forel)	30	26	26	35	38
<i>Pheidole bicarinata</i> Mayr	6	6	49	16	35
<i>Pheidole morrisii</i> Forel	5	2	0	19	81
<i>Prenolepis imparis</i> (Say)	47	7	79	21	0
<i>Tapinoma sessile</i> (Say)	61	12	46	35	19
<i>Temnothorax curvispinosus</i> (Mayr)	8	5	75	25	0
<i>Temnothorax longispinosus</i> (Roger)	4	2	100	0	0
<i>Temnothorax schaumii</i> (Roger)	11	6	46	54	0



**Table 3. Results of the Monte Carlo test evaluating the statistical significance of indicator values based on 1000 randomizations.** For each ant species, the table shows the dominant tree species (Max Group) based on a combination of relative abundance and relative frequency, the observed indicator value (Observed IV), and the mean and standard deviation for each indicator value from the randomized groups. Significant p values are in bold.

Species	Max Group	Observed IV	IV Randomized Groups		
			Mean	SD	p
<i>Aphaenogaster fulva</i>	Loblolly	2.7	3.1	1.28	0.548
<i>Aphaenogaster lamellidens</i>	Oak	13.8	14.1	2.33	0.475
<i>Aphaenogaster mariae</i>	Oak	8.2	3.1	1.22	<b>0.003</b>
<i>Aphaenogaster rudis</i>	Oak	12.8	13.6	2.49	0.582
<i>Camponotus castaneus</i>	Oak	1.9	2.3	1.05	0.633
<i>Camponotus chromaiodes</i>	Shortleaf	1.5	2.6	1.20	0.844
<i>Camponotus nearcticus</i>	Loblolly	2.5	3.7	1.30	0.814
<i>Camponotus pennsylvanicus</i>	Oak	6.2	2.0	0.95	<b>0.005</b>
<i>Camponotus snellingi</i>	Oak	2.3	2.4	1.15	0.512
<i>Crematogaster ashmeadi</i>	Loblolly	19.3	12.1	2.52	<b>0.018</b>
<i>Crematogaster cerasi</i>	Oak	1.2	1.7	0.89	0.698
<i>Crematogaster lineolata</i>	Oak	7.3	9.5	2.14	0.871
<i>Formica pallidefulva</i>	Oak	1.8	2.9	1.21	0.868
<i>Formica subsericea</i>	Oak	3.4	2.4	1.16	0.173
<i>Lasius alienus</i>	Oak	1.8	1.6	0.88	0.249
<i>Monomorium minimum</i>	Shortleaf	3.0	2.2	1.12	0.220
<i>Myrmica americana</i>	Oak	1.9	1.6	0.89	0.323
<i>Nylanderia faisonensis</i>	Shortleaf	5.5	6.0	1.59	0.527
<i>Pheidole bicarinata</i>	Oak	1.8	2.3	1.08	0.702
<i>Pheidole morrisii</i>	Shortleaf	1.1	1.5	0.70	0.434
<i>Prenolepis imparis</i>	Oak	5.9	2.8	1.25	<b>0.017</b>
<i>Tapinoma sessile</i>	Oak	2.3	3.9	1.56	0.876
<i>Temnothorax curvispinosus</i>	Oak	2.8	2.2	1.09	0.211
<i>Temnothorax longispinosus</i>	Oak	2.5	1.4	0.73	0.210
<i>Temnothorax schaumii</i>	Loblolly	2.6	2.3	1.05	0.302

We are more confident in the significant p-values for *A. mariae* and *C. ashmeadi*, because they were collected from a greater number of trees with greater abundances (Table 2), and because their life history suggests a strong association with trees. *Aphaenogaster mariae* was a significant indicator for oak; 48 individuals were collected on eight oaks (found at least once on all five species of oak surveyed), as compared to ten individuals collected from two loblolly pines. It was not collected from shortleaf pine. *Aphaenogaster mariae* nests under oak bark and in rotted tree cavities, and has also been observed foraging on oaks (Coovert 2005). This is consistent with our observations, as it was rarely discovered on pine. It is also noteworthy that despite extensive pitfall trapping and litter sampling at the same sites in 2008 and 2009, *A. mariae* was only found in a single pitfall trap and was never collected from the litter (J. A. Frye, unpublished data). This indicates that hand collection may be the best way to capture this species, and that

its absence from pitfall traps or litter samples does not necessarily indicate its absence from a site.

*Crematogaster ashmeadi* may also be well represented from direct hand collection from tree trunks as it is a true arboreal species. In Florida Coastal Plain pine forests, for example, it is considered to be the most dominant arboreal species (Tschinkel 2002). It showed a significant preference for loblolly pine followed by shortleaf pine, but was also found on oak (Table 2). Johnson (1988) described two morphs in the east, a black-bodied morph typically found on hardwoods and a bicolored morph typically found on pines, noting that in mixed hardwood and pine forests both morphs occur. None of the individuals that we collected were distinctly black-bodied, and the few that tended toward a darker morph were found just as often on pine as they were on oak.

Our ISA results could also indicate inadequate sampling. Even tree trunk surveys using bait have shown that the rate of detection of a species can be significantly lowered, especially if colonies are small, unless the tree is surveyed on multiple occasions. Tschinkel (2002) found that single-baited studies substantially underestimated the number of trees occupied by *C. ashmeadi*. Ants may have also gone undetected if they were using a part of the tree other than the lower trunk, which was the only part of the tree that we sampled, or if they preferentially foraged at night, since all of our surveys took place during the day. Despite this limitation, we were able to analyze data from 241 trees in 30 different dune and ridge woodland sites spanning two quadrangles, which should serve to document the species of ants present on pines and oaks in this rare community.

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**Summary and Taxonomic Index of *The Maryland Entomologist*:  
Volume 1, Number 1: February 1977 – Volume 5, Number 4: September 2012**

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### SUMMARY

*The Maryland Entomologist* began irregular publication in February 1977. Each volume contains four issues. The journal was originally called *Maryland Entomologist* from 1977 (Volume 1, Number 1) through 1992 (Volume 3, Number 4). Beginning in 1995 (Volume 4, Number 1), the name transitioned to *The Maryland Entomologist*. Five members of the Maryland Entomological Society have served as Editor throughout the years.

Ronald W. Hodges:	1(1): February 1977
Robert S. Bryant:	1(2): October 1978
	1(3): April 1979
	1(4): August 1980
	2(1): August 1981
	2(2): December 1982
	2(3): December 1983
	2(4): December 1984
Charles L. Staines, Jr.:	3(1): April 1987
	3(2): May 1988
	3(3): November 1989
Robert S. Bryant:	3(4): March 1992
	4(1): December 1995
Harold J. Harlan:	4(2): May 1998
	4(3): July 2003
Eugene J. Scarpulla:	4(4): September 2008
	5(1): September 2009
	5(2): September 2010
	5(3): September 2011
	5(4): September 2012

The journal's two most prolific authors have been Charles L. Staines, Jr. (Coleoptera) and Robert S. Bryant (Lepidoptera: moths). Other prolific authors have included Austin P. Platt (Lepidoptera: butterflies), H. G. Stevenson (Lepidoptera: moths) and John H. Fales (Lepidoptera: butterflies). These five authors are acknowledged for their significant contributions to the entomological knowledge of Maryland.

Articles in the index are grouped by insect order. The orders are listed taxonomically. Within each order, the articles are listed alphabetically by author. Miscellaneous categories (general, book reviews and notices, MES field trips, poetry and recent literature) follow the Taxonomic Index.

## TAXONOMIC INDEX

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## THE MARYLAND ENTOMOLOGIST

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## COVER PHOTOGRAPH

Laboratory-bred F<sup>1</sup> hybrid “arthechippus” Scudder. The parental cross involved a female nominate Viceroy, *Limenitis archippus archippus* (Cramer), from Central Maryland and a male White Admiral, *Limenitis arthemis arthemis* (Drury), from Starksboro, Vermont. The hybrid was reared on weeping willow, *Salix ×sepulcralis* Simonkai [*alba* × *pendulina*] (Salicaceae). December 1991.

Photographed by Austin P. Platt; photo adjusted by George M. Jett